(12.)

ON SOME POINTS

CONCERNING THE

MECHANISM OF THE HIP-JOINT.

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THE problem to be solved in the construction of the hip-joint is, that the joint possess solidity adequate to support the weight of the body, to resist the violent shocks to which it is exposed, and that it be freely moveable in all directions consistent with the requirements of the lower limbs. Now these purposes can only be accomplished by a ball-and-socket joint, and such an one nature has made in the very best possible manner.

By making sections through the fresh joint, it is observed that the respective surfaces of the head of the femur and of the acetabulum form segments of spheres of equal diameters, and that therefore they are accurately adapted each to the other. If we institute a comparison between the ball and socket of the hip, and the ball and socket of human contrivance, the great superiority of nature's work is at once evident. In the artificial ball and socket, it is essential that the socket form more than half a circle, else the ball would not be retained in it; the range of motion is therefore necessarily limited, since the stem to which the ball is fixed soon comes in contact with the margin of the socket. But the human acetabulum is part of a circle of less than 180°, and therefore the head of the femur has a very wide range of motion, as one may see in the tricks of mountebanks, who can raise their legs to their shoulders, and fall on their buttocks with their legs stretched out at a right angle.

In order to deepen the acetabulum, and to render it air-tight, its margin is provided with a ring of fibro-cartilage, commonly called the cotyloid ligament. This is a flexible, gradually shelving, lip, which, by virtue of its elasticity, embraces the head of the femur. Its component fibres run parallel to the margin of the acetabulum, and pass uninterrupted across the notch at the lower part of it. The use of this elastic ring is to act like a valve or sucker to the acetabulum, and to keep it, as it were, hermetically sealed. The capsule of the hip may be completely distended with fluid, without any risk of the fluid entering the acetabulum, so long as the sucker is in proper action. But let ever so small a quantity of fluid be secreted within the acetabulum, the consequence is, that the head of the femur ceases to be in accurate contact with its socket; the sucker is presently raised by the junction of the fluid within and without the acetabulum, and thus it happens that the limb not only becomes lengthened, but it may even be spontaneously dislocated, provided the ligaments have sufficiently yielded.

In the ball and socket of human contrivance, it is obvious that the ball is held fast by the constriction of the mouth of the socket itself. But in the hip-joint, the power which holds the head of the femur in the acetabulum is atmospheric pressure. From the very construction of the parts, any one in the least degree familiar with natural philosophy will see at once that it must be so. But it is easily proved by direct experiment. If all the soft parts including the capsule be removed from the joint, we find that the head of the femur is still held in the acetabulum,

and that it requires a very considerable force to pull it out. The precise amount of this force can be readily estimated by ascertaining the superficial area of the acetabulum, and allowing 15 lbs. for every square inch of surface. But without making any such calculation, it may be asserted that the amount of atmospheric pressure is more than sufficient to sustain the weight of the entire limb when freely suspended in the air.

Now the object attained by the limb being held in its socket by atmospheric pressure, is, the saving of muscular exertion in locomotion. The head of the femur, supported by the air, moves with the greatest freedom, and with the least possible amount of friction, in the acetabulum; so that, in walking, the hinder leg, once raised from the ground, swings, by the mere force of its own weight, in advance of the other. During this spontaneous movement of the leg, all its muscles are in a state of complete repose. This fact explains, what is matter of common observation, why a man can walk, during a given number of hours, with less fatigue than it would cost him to stand still.

Such being the organization of the hip-joint, one might suppose that the range of its motion would be almost as free as that of the shoulder. But, since this would ill accord with the security of the erect posture, we find that nature has restricted its motion in certain directions by means of ligaments extending from the pelvis to the thigh. Of these there are two,—the *capsular* and the *round*.

The *capsular* ligament not only serves to strengthen the joint, but plays a most important part in restricting the motions of the thigh. In a general way, it may be said that the upper end is attached round the margin of the acetabulum, and the lower to the base of the neck of the femur; not, however, round its entire circumference, as is commonly described, but only along its front and upper part. At its back part the capsular ligament simply embraces the neck in the same manner as the annular ligament embraces the head of the radius. Now the anterior part of the capsule is remarkably thick and strong. It is, indeed, the strongest ligament in the body, —stronger than the tendo Achillis or the ligamentum patellæ. To understand its purpose and design, we should observe that it descends from the upper part of the circumference of the acetabulum, downwards and outwards to the anterior inter-trochanteric ridge of the femur, this ridge being specially intended for its attachment. In the erect posture, this part of the capsule is fully on the stretch, and therefore it limits any backward movement of the thigh on the pelvis, or of the pelvis on the thigh. Besides, however, its power of limiting backward movement, a glance at its attachment shows that it limits adduction of the thigh,—in other words, it prevents the pelvis from rolling towards the opposite side, while we are standing on one leg; and in this latter respect it co-operates, as will be seen presently, with the ligamentum teres.

The posterior part of the capsular ligament, which simply embraces the neck of the femur, may very properly be called the annular ligament of the hip. One sees clearly why it should not have been attached to the femur; for, had it been *so*, it must of necessity have presented an obstacle to the free bending of the pelvis on the thigh,—as, for instance, in sitting or stooping.

Lastly, we have to consider the action of the ligamentum teres. This is placed inside the acetabulum, and it is attached respectively to the borders of the acetabular notch and to the head of the femur. Its presence in the acetabulum would have prevented the accurate adaptation of the ball and socket, if the bottom of the socket had not been excavated expressly for its reception and free play. The room not occupied by the ligament is filled up by soft fat, which serves merely a mechanical purpose.

The reason why anatomists have been generally misled as to the use of the round ligament, is, that they have not properly calculated the true inclination of the pelvis, and consequently the precise direction of the ligament in the erect posture. The pelvis in the erect attitude is so inclined, that it forms with the horizon an angle of 60°. Now if a pelvis be held at this angle, we find that the notch to which the ligament is attached will be at the lowest part of the acetabulum. Again, by making a vertical section through the head of the femur, we may ascertain that the ligament, in *the erect position*, is not only vertical, but fully on the stretch. Consequently its action is to assist the anterior part of the capsule in preventing

the tendency of the pelvis to roll over towards the opposite side, *i. e.* while we are standing upon one leg.

Upon the whole, then, it appears that the disposition of the ligaments is such as to maintain the pelvis steadily upon the head of even one thigh bone, without the co-operation of any muscles except those which counteract the tendency of the trunk to fall forwards.

Besides its peculiar action as a ligament, the ligamentum teres serves to convey blood-vessels to the head of the thigh bone. This fact is at variance with the statements of many modern anatomists, who affirm that the blood-vessels do not enter the head of the bone, but return in a loop-like manner. There is, however, a preparation on the table, in which the vessels are clearly traced into the cancellous structure of the head of the femur.